

What is claimed is:

1. An apparatus for use with a vehicle for repeatedly measuring road surface conditions, comprising:

a test wheel, separate from the vehicle wheels, attached to said vehicle and positioned for contact with a road surface, so as to rotate due to contact with said road surface upon movement of said vehicle;

means for applying a variable electro-magnetic field torque opposing rotation of said test wheel, so as to produce slippage of said test wheel;

means for measuring an amount of voltage utilized in said electro-magnetic field applying means and for providing a voltage measurement signal corresponding thereto;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal and said voltage measurement signal, said controller generating an output signal in response to a slip condition of said test wheel based on said test wheel rotation speed signal and said voltage measurement signal, and

means for providing an indication of said output signal.

2. The apparatus as claimed in claim 1, further comprising:

means for generating a reference signal indicative of the speed of said vehicle, wherein said controller is connected to receive said reference signal and generates said output signal in response to said test wheel rotation speed signal and said reference signal.

3. The apparatus as claimed in claim 1, wherein said variable torque applying means is connected to receive said output signal and varies the magnitude of said variable torque in response thereto.

4. An apparatus, for use with a vehicle having wheels, for repeatedly measuring road surface conditions, comprising:

a test wheel, separate from the vehicle wheels, attached to the vehicle and positioned for contact with a road surface so as to rotate upon movement of the vehicle;

means for applying a variable, electro-magnetic field, accelerative torque to produce slippage of said test wheel;

means for measuring an amount of voltage utilized in applying said accelerative torque and for providing a voltage measurement signal corresponding thereto;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal and said voltage measurement signal, said controller generating an

output signal in response to a slip condition of said test wheel based on said test wheel rotation speed signal and said voltage measurement signal; and

means for providing an indication of said output signal.

5. The apparatus as claimed in claim 4, further comprising:

means for continuously producing a vertical force test signal representative of the vertical force acting on said test wheel, and wherein said controller is further responsive to said vertical force test signal to produce said output signal.

6. An apparatus, for use with a vehicle having wheels, for repeatedly measuring road surface conditions, comprising:

a test wheel, separate from the vehicle wheels, attached to the vehicle and positioned for contact with a road surface so as to rotate upon movement of the vehicle;

means for applying a variable torque to produce slippage of said test wheel;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal, said controller generating an output signal in response to a slip condition of said test wheel; and

means for providing an indication of said output signal.

7. A method for continuously monitoring road surface friction, comprising the following steps:

- (a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;
- (b) applying an increasing resistance to said test wheel to resist rotation thereof;
- (c) detecting a first instance of slip condition of said test wheel on said road surface;
- (d) generating a signal representative of the braking torque required to produce said incipient slip condition; and
- (e) providing an indication of said slip detection signal.

8. A method for continuously monitoring road surface friction, comprising the following steps:

- (a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;
- (b) applying an accelerative force to said test wheel to produce slippage thereof;
- (c) detecting a first instance of said slip condition of said test wheel on said road surface;
- (d) generating a slip detection signal at the time of said first instance of a slip condition, said slip detection signal

representative of a value of said torque at the first instance of a slip condition; and

(e) providing an indication of said slip detection signal.

9. A method for continuously monitoring road surface friction, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;

(b) applying a variable torque to said test wheel to produce slippage therefor;

(c) detecting a first instance of slip condition of said test wheel on said road surface;

(d) generating a slip detection signal at the time of said first instance of a slip condition; and

(e) providing an indication of said slip detection signal.

10. A method for repeatedly testing road surface conditions, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate due to movement of said vehicle along said road surface;

(b) applying a fixed resistance to said test wheel to resist rotation thereof;

(c) generating a slip detection signal indicative of a slip condition of said test wheel on said road surface; and

(d) providing an indication of said signal.

11. A method for repeatedly testing road surface condition, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate due to movement of said vehicle along said road surface;

(b) applying a plurality of increasing, pre-determined resistances to said test wheel to resist rotation thereof;

(c) generating a slip detection signal indicative of a slip condition of said test wheel on said road surface for each of said plurality of pre-determined resistances; and

(d) providing an indication of said signal for each of the said plurality of predetermined resistances.

12. A method for continuously monitoring road surface friction, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;

(b) applying an increasing resistance to said test wheel to resist rotation thereof;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said road surface;

(d) detecting a first instance of slip condition of said test wheel on said road surface;

(e) generating a signal representative of the braking torque required to produce said incipient slip condition; and

(f) providing an indication of said slip detection signal.

13. A method for continuously monitoring road surface friction, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;

(b) applying an accelerative force to said test wheel to produce slippage thereof;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said road surface;

(d) detecting a first instance of said slip condition of said test wheel on said road surface;

(e) generating a slip detection signal at the time of said first instance of a slip condition, said slip detection signal representative of a value of said torque at the first instance of a slip condition; and

(f) providing an indication of said slip detection signal.

14. A method for continuously monitoring road surface friction, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate freely due to movement of said vehicle along said road surface;

(b) applying a variable torque to said test wheel to produce slippage therefor;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said road surface;

(d) detecting a first instance of slip condition of said test wheel on said road surface;

(e) generating a slip detection signal at the time of said first instance of a slip condition; and

(f) providing an indication of said slip detection signal.

15. A method for repeatedly testing road surface conditions, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate due to movement of said vehicle along said road surface;

(b) applying a fixed resistance to said test wheel to resist rotation thereof;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said road surface;



(d) generating a slip detection signal indicative of a slip condition of said test wheel on said road surface; and

(e) providing an indication of said signal.

16. A method for repeatedly testing road surface condition, comprising the following steps:

(a) positioning a test wheel, attached to a vehicle, for contact with a road surface so as to rotate due to movement of said vehicle along said road surface;

(b) applying a plurality of increasing, pre-determined resistances to said test wheel to resist rotation thereof;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said road surface;

(d) generating a slip detection signal indicative of a slip condition of said test wheel on said road surface for each of said plurality of pre-determined resistances; and

(e) providing an indication of said signal for each of the said plurality of predetermined resistances.

17. An apparatus for repeatedly measuring road surface conditions, comprising:

a test wheel, attached to a vehicle and positioned for contact with a road surface, so as to rotate due to contact with said road surface upon movement of said vehicle;

means for applying a variable resistance opposing rotation of said test wheel;

electromagnetic means for applying a controlled force to said test wheel, said force normal to said surface;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal, said controller generating an output signal in response to a slip condition of said test wheel; and

means for providing an indication of said output signal.

18. An apparatus for repeatedly measuring road surface conditions, comprising:

a test wheel, attached to a vehicle and positioned for contact with a road surface, so as to rotate due to contact with said road surface upon movement of said vehicle;

means for applying a variable accelerative torque to said test wheel;

electromagnetic means for applying a controlled force to said test wheel, said force normal to said surface;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal, said controller generating an output signal in response to a slip condition of said test wheel; and

means for providing an indication of said output signal.

19. Apparatus as recited in claim 18, further comprising means for continuously producing a normal force test signal representative of the normal force acting on said test wheel, and wherein said controller is further responsive to said normal force test signal to produce said output signal.

20. An apparatus for repeatedly measuring road surface conditions, comprising:

a test wheel, attached to a vehicle and positioned for contact with a road surface, so as to rotate due to contact with said road surface upon movement of said vehicle;

means for applying a variable torque to produce slippage of said wheel;

electromagnetic means for applying a controlled force to said test wheel, said force normal to said surface;

means for measuring a rotation speed of said test wheel and generating a test wheel rotation speed signal;

a controller connected to receive said test wheel rotation speed signal, said controller generating an output signal in response to a slip condition of said test wheel; and

means for providing an indication of said output signal.

21. The apparatus as claimed in claim 17, further comprising:

means for generating a reference signal indicative of the speed of said vehicle, wherein said controller is connected to receive said reference signal and generates said output signal in response to said test wheel rotation speed signal and said reference signal.

22. The apparatus as claimed in claim 17, wherein said variable resistance applying means is connected to receive said output signal and varies the magnitude of said variable force in response thereto.

23. A device for applying a vertical force to a surface friction measuring test wheel comprising:

(a) a test wheel moveable attached to a fixed point of support, a slip condition of said test wheel providing an indication of surface friction of a surface; and

(b) electromagnetic force field applying means to bias said test wheel into contact with measured surface.

24. A method for applying a vertical force to a surface friction measuring test wheel to measure a friction condition of said surface comprising the steps of:

(a) providing a test wheel pivotally attached to fixed point of support; and

(b) electromagnetically controllably biasing said test wheel into engagement with said surface to produce a controllable contact force between said test wheel and said surface.

25. A method for continuously monitoring a surface friction, comprising the following steps:

(a) positioning a test wheel for contact with said surface so as to rotate freely due to relative movement of said wheel along said surface;

(b) applying an increasing resistance to said test wheel to resist rotation thereof;

(c) applying an electromagnetically controllable normal force to bias said test wheel against said surface;

(d) detecting a first instance of slip condition of said test wheel on said surface;

(e) generating a signal representative of the braking torque required to produce said incipient slip condition; and

(f) providing an indication of said slip detection signal.